

Chapter One: Mercury All Around Us

Properties and Uses of Mercury

Mercury is an Element

Imagine, long ago, hot lava flowing down a volcano in Italy. Deep within the cooling layers of rock, water rises on its way toward the surface. As the water rises it leaves deposits of sulfur,



Figure 1. Elemental mercury sitting atop cinnabar

forming a red-colored mineral called cinnabar, or mercury sulfide. Elemental mercury constitutes only 0.5 parts per million of the earth's crust, making it scarcer than uranium but more plentiful than gold or silver. Ancient Romans mined cinnabar for mercury; some of the ancient Roman mines are still in use today. In Roman mythology, Mercury was a swift messenger of the gods. Elemental mercury, which is the only metal that is a liquid at room temperature, got its name from the Roman god because its high surface tension causes it to form spheres that can roll and flow very quickly. For this reason, and because it

is a silver-white metal, mercury is also called quicksilver.

Mercury has Many Uses

Mercury has been found in Egyptian tombs dating back to 1500 B.C., and it has been used for centuries in medicines. While mercury is no longer sold as a dermal or oral antiseptic, an organic form continues to be used as a vaccine preservative. The ancient Greeks and Romans used mercury in cosmetics and it was also one of the primary cures for syphilis in Europe before modern times. During the medieval period, alchemists thought mercury could be hardened to produce gold. In some cultures, spiritualists associate mercury with mystic qualities and it continues to be used to “bless” homes, cars and apartments. Although its toxic effects are well understood, mercury continues to be used in a wide variety of products and manufacturing processes because it is very useful (Table 1).



Figure 2. Mercury is put in amulets by Central American spiritualists.

Elemental mercury is used in thermometers, blood pressure devices, and thermostats because its ability to expand and contract uniformly makes it useful for measuring changes in temperature and pressure. Although many liquids could be used in pressure measuring devices, mercury is used because its high density requires less space. It is also a good conductor of electricity, so it is a useful component of electrical switches.

Mercury is also used in dental fillings, paints, soaps, batteries, and fluorescent lighting. Mercury will dissolve numerous metals to form amalgams and is used to extract gold dust from rocks by dissolving the gold and then boiling off the mercury. The amalgam used in dental fillings

contains tin and silver alloyed with mercury. Because it works as a biocide, mercury has been used as a fungicide in paint, though this kind of paint is no longer sold.

Table 1. Properties and Uses Of Mercury	
PROPERTIES	USES
1. Liquid metal	1. Barometers, blood pressure cuffs
2. Expands/contracts with temperature	2. Thermometers
3. Conducts electricity	3. Switches, fluorescent bulbs, electrolytic production of chlorine
4. Amalgamates with other metals	4. Dental fillings, gold purification
5. Kills bacteria and fungi	5. Disinfectants, preservatives

Other Forms of Mercury

Inorganic mercury compounds occur when mercury combines with elements such as chlorine, sulfur, or oxygen, and some of these compounds can be created in a lab. These mercury compounds are also called mercury salts. Most inorganic mercury compounds are white powders or crystals, except for cinnabar (HgS), which is red and turns black after exposure to light. Some inorganic mercury compounds, such as mercuric chloride (HgCl₂), are violent poisons.



Figure 3. Elemental mercury. Its symbol on the periodic table of elements is "Hg."

When mercury combines with carbon, the compounds formed are called "organic" mercury compounds or organomercurials. There are a potentially large number of organic mercury compounds, but the most common organic mercury compound in the environment is methylmercury (HgCH₃). When elemental mercury enters a water body, certain microorganisms can convert it to methylmercury during their normal metabolic processes. Methylmercury is the form that ends up in fish tissue and is ingested by humans.

Mercury Release

Releases to the Environment

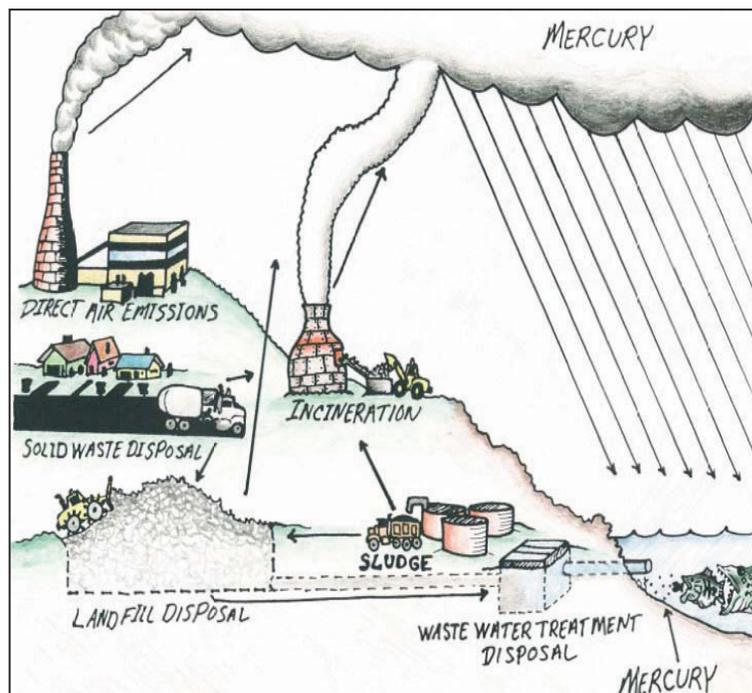
Mercury releases to the environment are from two main sources, nature and humans. Natural sources include mercury that is mobilized from the earth's crust, through volcanic activity, weathering of rocks, or forest fires. Today, most of the mercury that makes its way into the environment comes from anthropogenic (human-caused) sources.

Coal-fired power plants are the largest source of mercury released into the atmosphere, about 1,200 kg of mercury each year in Wisconsin. But mercury is also released from products and

processes during manufacture, breakage or spillage during use, and during disposal (Table 2). Remobilization of historic mercury occurs when mercury deposits from soils, sediments, water bodies, landfills, and waste tailings are disturbed.

Table 2: Estimated Mercury Distribution in Wisconsin in Year 2000 From the Most Common Mercury-Containing Products					
PRODUCT	To:	Air	Water	Land	Total
Dental Amalgam ¹		205	23	883	1111
Thermostats		139	1	517	657
Fever thermometers		68	0	199	267
Fluorescent bulbs		91	0	172	263
Automobile switches		43	0	66	109
TOTALS²		546	24	1837	2407
units in kg Hg/year (kg = 2.2 lbs)					

1. Mercury bound in an alloy with other metals.
 2. An additional 600 kg Hg/year is released from other products not listed in Table 2.
- Source: Barr Engineering, Minneapolis, MN and Wisconsin Department of Natural Resources.



Mercury Deposition

The deposition rates of mercury today are 1.5 to 3 times higher than they were before the industrial age. When mercury is discharged to land or water, it doesn't degrade over time. Instead, it evaporates and enters the atmosphere. Once in the atmosphere, mercury can travel for hundreds or thousands of miles before raining down on land or the surface of an ocean or lake (Figure 4). These storms are equal opportunity providers – they rain on countries and isolated locations where no man-made pollutants are produced.

Figure 4. Mercury gets into the air from several sources including coal burning and waste incineration, and it gets into wastewater from places like dental offices, schools, medical facilities, and homes. Some of this mercury eventually ends up in the fish we eat. Bioaccumulation causes the mercury concentration to be much greater in the fish than in the water.

At the same time, mercury can also be discharged from sources very close to home. In the U.S., mercury in the atmosphere tends to travel east with prevailing winds, where it rains out along the eastern seaboard (Figure 5).

What's the Problem with Mercury? It's In the Fish

Health Problems and Mercury

People can come into contact with mercury by breathing vapors, skin absorption, and ingestion. Breathing the vapors is particularly dangerous, and can happen in the home, workplace, or anywhere mercury has been spilled. When metallic mercury is touched it can slowly pass through the skin. Metallic mercury generally does not absorb very well when swallowed. However, people can be exposed to mercury by eating fish or shellfish caught in contaminated waters. Mothers who eat these fish pass mercury to their fetuses, where it can damage the developing brains of children and may affect a child's behavior, memory, and ability to learn. In adults, accumulation of mercury can also affect the nervous system and result in a range of other health effects, including irritability, loss of coordination, and liver and kidney damage.

National Atmospheric Hg Deposition

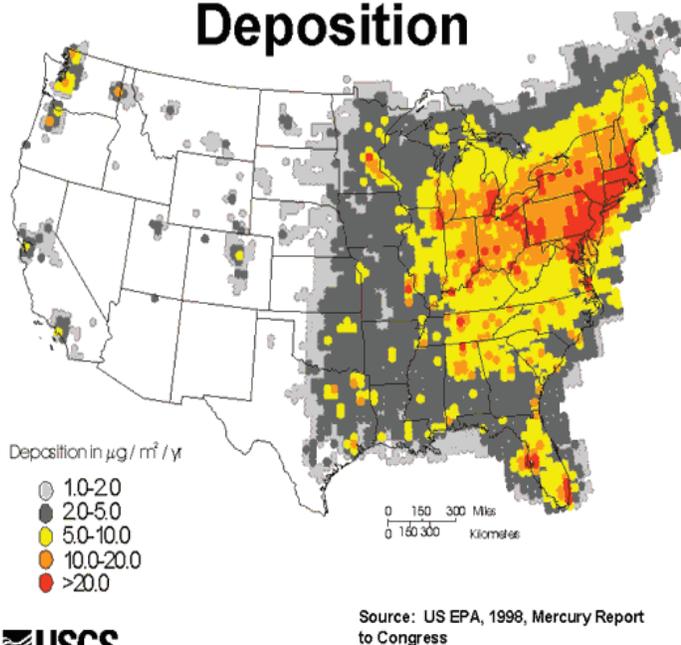


Figure 5. Mercury released into the air in industrial areas tends to blow east with prevailing winds.

The most common way that people and animals are exposed to mercury is by eating contaminated fish. The mercury that falls out of the atmosphere into waterbodies and the mercury being discharged from wastewater effluent isn't highly concentrated. However, microbes in the sediment at the bottom of a lake or stream can convert mercury into methylmercury, which is a toxin of great concern. Small organisms, such as zooplankton, consume the microbes that contain methylmercury; this buildup of mercury in their tissues is called **bioaccumulation**. Small fish eat the contaminated zooplankton, and larger fish eat the smaller fish. Mercury increases up the food chain until it is many times more concentrated in living organisms than in the surrounding water, in a process called bioconcentration or **biomagnification**.

The mercury taken up by fish is distributed throughout its body, including the fillets that people eat. Specific cooking methods and trimming fat can reduce some chemicals but they do not reduce mercury in the portions typically eaten by people. When people and animals eat a lot of large predatory fish, they can accumulate enough methylmercury in their bodies to cause health problems. Methylmercury buildup in fish-eating wildlife has been linked to reproductive problems, impaired growth and development, behavioral abnormalities, and even death.

Table 3: Wisconsin's Safe Eating Guidelines for Sport Fish

*Women of childbearing years, nursing mothers and all children under 15 may eat:**

1 meal per week	Bluegill, sunfish, black crappie, white crappie, yellow perch or bullheads,
	AND
1 meal per month	Walleye, northern pike, smallmouth bass, largemouth bass, channel catfish, flathead catfish, white sucker, drum, burbot, sauger, sturgeon, carp, white bass, rock bass or other species.

**Muskie should not be eaten by this group of people due to high mercury content.*

Men, and women beyond their childbearing years may eat:

Unlimited amounts	Bluegill, sunfish, black crappie, white crappie, yellow perch, or bullheads,
	AND
1 meal per week	Walleye, northern pike, smallmouth bass, largemouth bass, channel catfish, flathead catfish, or other species.

Additional restrictive advice is necessary for some waters where fish have been found to contain higher levels of mercury. See www.dnr.wi.gov/org/water/fhp

Fish purchased in stores and restaurants may also contain contaminants. Follow these guidelines for popular commercial species to reduce your exposure to mercury:

Purchased Species	Women of child-bearing age and children under 15	Women beyond child-bearing age, and men
Salmon, shrimp, canned light tuna, pollock, catfish	2 meals per week	Unlimited consumption
Canned white tuna, tuna steaks, halibut	2 meals per month	1 meal per week
Shark, swordfish, king mackerel, tilefish	Do Not Eat	1 meal per month

In 2003, 45 states had mercury-related fish consumption advisories. Some advisories are statewide, while others apply to certain lakes, rivers, or coastal areas. Currently (2005), the “Safe Eating Guidelines” for mercury listed above apply to all Wisconsin lakes and rivers (other than the Great Lakes). Additional consumption advice applies to 94 waters due to particularly high concentrations of mercury. Advisories are updated as additional data are obtained. Because of the impact of mercury on the developing nervous system, children, pregnant women, and women of childbearing age must monitor their consumption of sport-caught and commercial fish. The nutritional benefit of eating fish will outweigh the risk posed by mercury as long as advisory guidelines are followed.

It's in Products that Break or Spill

Mercury-containing products do not pose a health risk as long as they are handled correctly and disposed of safely. If they are broken, liquid mercury will evaporate at room temperature and form mercury vapors. Mercury vapors are colorless and odorless, and inhaling the invisible vapor can lead to serious mercury poisoning. The higher the temperature, the more vapors will be released from liquid metallic mercury. Some people who have breathed mercury vapors report a metallic taste in their mouths. Even a small amount of mercury can lead to health and environmental problems.



Figure 6. Mercury-containing thermometers.

A Green Bay High School student took a bottle of mercury from the school's science lab in March 1999. She shared it with friends who poured the mercury on their skin and brought it to a bowling alley, where they filled the finger holes of the bowling balls and rolled them down the lanes. When the mercury spill was discovered, students were detained in their classrooms until the extent of the spill was ascertained. Four students were sent to the hospital and 88 students were put in decontamination showers, though no one was permanently injured. The total cost of the mercury spill at the school, a home, and the bowling alley was \$230,000, though the cost was settled at \$175,000. The family of the student who stole the mercury paid \$6,000 in restitution while the remaining costs were paid by the school district.

Universal Wastes

In order to promote collection and recycling of mercury-containing products, the U.S. EPA and WDNR have included the most common mercury products in their Universal Waste Rules. These rules reduce handling and transportation requirements for wastes that otherwise would need to be managed as "hazardous wastes." But inclusion in the Universal Waste Rules, or in some cases complete exemption from Hazardous Waste Rules, is only permitted where the mercury products are recycled. Most mercury products not recycled must be managed as hazardous wastes. For more information see EPA's Discarded Mercury-Containing Equipment Rule webpage at

www.epa.gov/epaoswer/hazwaste/recycle/electron/crt.htm

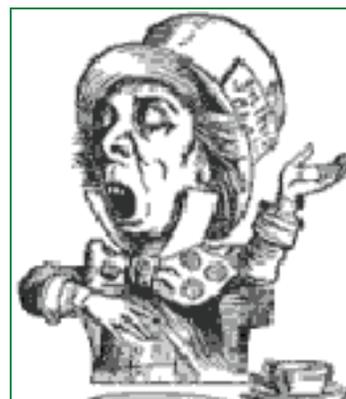


Figure 7. **Chronic Mercury Exposure:** Mercuric nitrate was used in the hat-making industry up until the 1940s. Hat-makers in Danbury, Connecticut developed a reputation for strange behavior related to their exposure to mercury, and the "Danbury shakes" was a term that referred to the tremors that resulted from mercury poisoning.

Sources:

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